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NATIONAL DAM INSPECTION PROGRAM. CLOVER DAM (NDI ID NUMBER PA-4--ETC(U)
JUN 80 DACW31-80-C-0022

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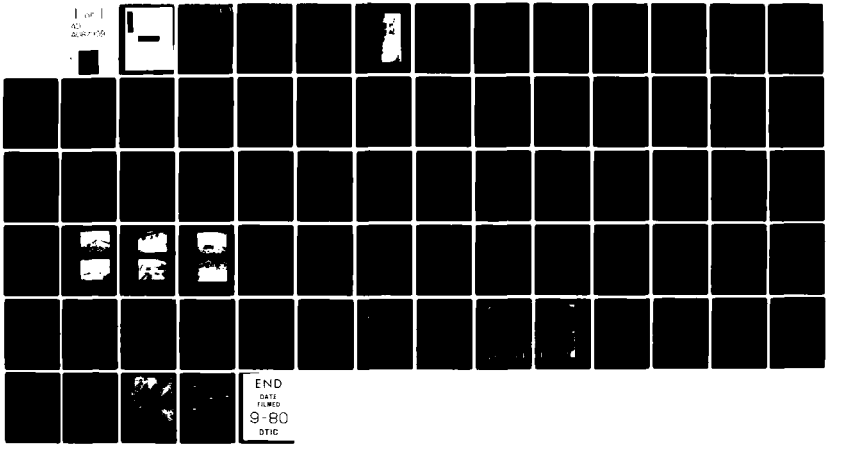

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D'APPOLONIA CONSULTING ENGINEERS
DACW31-80-C-0022 ✓

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Clover Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Jefferson
STREAM: Clover Run, a Tributary of the East Branch of Mahoning Creek
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: High
OWNER: Western Pennsylvania Water Company
DATE OF INSPECTION: April 22, 1980 and April 30, 1980

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Clover Dam is considered to be unsafe/nonemergency. The dam consists of an earth embankment constructed around timber cribbing filled with stone and earth materials. In view of the structurally uncertain character of the embankment materials and the fact that significant signs of distress, such as downstream slope irregularities and sinkholes, were observed, further investigation of the integrity of the embankment as an impounding structure should be immediately investigated. The spillway structures were also found to be in poor condition, in need of repair and restoration. Two intake towers on the upstream side of the dam were abandoned and the operating equipment was dismantled.

The flood discharge capacity of the dam was evaluated according to the recommended procedure and was found to pass approximately 15 percent of the probable maximum flood (PMF) without overtopping the low spot on the embankment. This capacity is less than the recommended spillway capacity range of half to full PMF. Considering the height of the embankment and the downstream damage potential, the lower limit of the recommended spillway capacity range is considered to be applicable to this dam. Because the spillway capacity is less than the recommended capacity, it is classified as inadequate. However, it was not considered to be seriously inadequate because the downstream flood stage would not be significantly increased in the event of a dam failure.

The following recommendations should be implemented as soon as possible or on a continuing basis:

1. The owner should immediately retain a professional engineer experienced in the design and construction of dams for detailed evaluation of the dam and spillway facilities to prepare and execute plans for:

a. Evaluating the structural integrity of the embankment in view of the design features and the observed conditions;

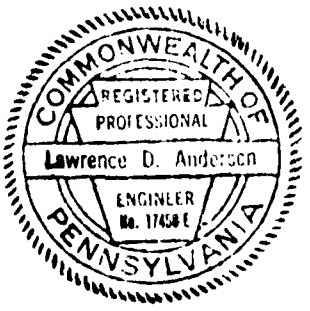
b. Initiating additional detailed hydrologic and hydraulic studies to more accurately ascertain the spillway capacity and to determine the nature and extent of improvements required to provide adequate spillway capacity; and

c. Repair and restoration of the intake towers to provide upstream control of the outlet pipes through the embankment.

The detailed evaluation of the dam should include, but not be limited to, subsurface investigation, material testing, instrumentation, and stability and seepage analyses. In conjunction with the detailed investigation, the crest of the dam should be surveyed and filling of the low areas along the crest of the dam should be considered.

2. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

3. The dam and appurtenant structures should be inspected regularly and a formal maintenance manual should be developed for future maintenance of the dam.



Lawrence D. Andersen, P.E.
Vice President

June 18, 1980
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

11 July 1980
Date

CLOVER DAM
NDI I.D. PA-420
DER I.D. 33-4
APRIL 22, 1980

Overview

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

(15) DACW31-80-C-0020

(11) 18 Jun 80 (12) 70

(6)

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
CLOVER DAM
(NDI I.D. PA-420,
DER I.D. 33-4) Ohio River Basin, Clover

Number

Fay[illegible] County, Pennsylvania.

SECTION 1 Phase I Inspection Report.

PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Clover Dam consists of an earth embankment constructed around timber cribbing filled with stone and earthen materials. The dam has a crest length of approximately 550 feet with a maximum height of approximately 31 feet from the downstream toe. The crest width of the dam is about 25 feet with a downstream slope of 2.5H to 1V. A portion of the downstream slope near the left abutment is steeper (approximately 1H:1V). A steel sheet-pile wall exists along the upstream edge of the crest for the total length of the embankment. The sheet piling appears to be battered (approximately 1H:3V).

The flood discharge facilities for the dam consist of an overflow spillway located at the center of the embankment. The steel sheet piling on the upstream face of the dam continues across the crest of the spillway. The spillway is approximately 60 feet long and is about 3-1/2 feet deep at the right abutment wall. The spillway discharge channel is a rectangular reinforced concrete channel. The channel is 61 feet wide at the overflow section and then converges uniformly to a width of about 40 feet at midheight of the embankment. The discharge channel terminates at a plunge pool at the toe level of the dam. Commonwealth inspection reports indicate that the spillway discharge channel was directly founded on timber cribbing.

The outlet facilities for the dam consist of two intake towers located on the upstream side of the dam immediately left of the

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spillway, a 20-inch cast-iron blow-off pipe, and a 12-inch cast-iron supply pipe. Currently, flow through these pipes is controlled by valves situated in a valve chamber located near the downstream slope of the dam left of the spillway discharge channel. Previous inspection reports indicate that originally flow through these pipes was controlled by valves located in the upstream intake towers. Currently, the intake towers are abandoned and all the regulating facilities are dismantled. The 20-inch blow-off pipe constitutes the emergency drawdown system for the reservoir.

b. Location. Clover Dam is located on Clover Run approximately 3-1/2 miles upstream from its mouth on Mahoning Creek in Gaskill Township, Jefferson County, Pennsylvania. Plate 1 shows the location of the dam.

c. Size Classification. Small (based on 31-foot height and 101 acre-feet maximum storage capacity).

d. Hazard Classification. The dam is classified to be in the high hazard category. Below the dam, Clover Run flows through an uninhabited valley for approximately 2.5 miles. At the end of this reach, a water treatment plant is located within the flood plain of Clover Run. Below this reach, Clover Run continues to flow through an uninhabited valley, flowing under the Baltimore and Ohio Railroad immediately upstream from the confluence with Mahoning Creek. Residential areas of the community of Big Run are located in the vicinity of the confluence of Clover Run and Mahoning Creek. It is estimated that failure of the dam would cause loss of life and property damage at the water treatment plant and further downstream in Big Run.

e. Ownership. Western Pennsylvania Water Company (address: Mr. D. W. McAdams, Division Engineer, 203 Sycamore Street, Punxsatawney, Pennsylvania 15767).

f. Purpose of Dam. Water supply.

g. Design and Construction History. The dam was built in 1896 by the Punxsatawney Water Company. Available information indicates that the original dam consisted of a timber crib structure. Subsequent to overtopping failure of the dam in 1911, the dam was enlarged by placing additional fill on the upstream and downstream faces of the timber crib structure and the height of the embankment was increased by five feet. The steel sheet piling on the upstream side of the dam was placed in 1974.

h. Normal Operating Procedure. The reservoir is maintained at or above the uncontrolled spillway elevation with inflow discharging over the spillway.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were calculated based on approximate field measurements assuming the spillway crest level (normal pool level) to be at Elevation 1555 (USGS Datum), which was interpolated from the USGS 7.5-minute McGees Mills quadrangle map, photorevised 1973.

a. Drainage Area	6.7 square miles
b. Discharge at Dam Site (cfs)	
Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	20± (estimated)
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	1745
Total spillway capacity at maximum pool	1745
c. Elevation (USGS Datum) (feet)	
Top of Dam	1557.9 (measured low spot on crest; design elevation unknown)
Maximum pool	1557.9
Normal pool	1555
Upstream invert outlet works	Unknown
Downstream invert outlet works	1520±
Maximum tailwater	Unknown
Toe of Dam	1527±
d. Reservoir Length (feet)	
Normal pool level	900
Maximum pool level	1000±
e. Storage (acre-feet)	
Normal pool level	65
Maximum pool level	101±
f. Reservoir Surface (acres)	
Normal pool level	7.3
Maximum pool level	9±

g. Dam

Type	Earth
Length	550 feet
Height	31 feet
Top width	25+ feet
Side slopes	Downstream: 2H:1V; Upstream: Battered (1H:3V)
Zoning	No
Impervious core	No
Cutoff	No
Grout curtain	No

h. Regulating Outlet

Type	20-inch cast-iron pipe
Length	250+ feet
Closure	Downstream valve
Access	Valve chamber
Regulating facilities	Downstream valve

i. Spillway

Type	Rectangular overflow section
Length	61 feet (perpendicular to flow)
Crest elevation	1555
Upstream channel	Lake
Downstream channel	Concrete channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available data consist of files provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), which contain a limited set of design drawings, correspondence, and past inspection reports. An additional set of drawings was also provided by the owner.

(1) Hydrology and Hydraulics. The available information includes the design capacity of the spillway.

(2) Embankment. The available information includes a limited set of design drawings and a description of the dam included in the past inspection reports.

(3) Appurtenant Structures. The available information consists of a description of the facilities included in the previous inspection reports.

b. Design Features

(1) Embankment. Plate 2 illustrates the plan and typical cross sections of the dam. The dam as built in 1896 consisted of a timber crib structure filled with stone and earth material with an essentially vertical upstream slope and a 1.5H to 1V downstream slope. The records indicate that while most of the timber cribbing was placed directly on the natural ground surface, a 4-foot-thick, 20-foot-wide concrete mat was constructed as the foundation for the timber cribbing in the middle 200-foot section of the embankment. It was further noted that on this prepared foundation, two layers of 2-1/2-inch-thick pine planks were fastened to the concrete and the first row of timber cribs was nailed to the planking. The presently existing upstream steel sheet piling was constructed in 1974. Plate 3 illustrates the details of the steel sheet pile construction.

(2) Appurtenant Structures. The appurtenant structures consist of an open channel spillway located at the center of the embankment and outlet works. The plan and profile of the spillway are shown in Plate 3. No drawings were available on the details of the outlet facilities. As described in the previous Commonwealth inspection reports, the outlet pipes consist of a 20-inch blow-off pipe and 12-inch supply line which receive flow from two intake towers located on the upstream side of the dam. As they currently exist, the intake towers are abandoned and all the regulating

controlled by a valve located at a valve chamber at the downstream toe of the dam. The downstream end of the blow-off pipe is located approximately 200 feet from the downstream toe within the streambed.

c. Design Data

(1) Hydrology and Hydraulics. The available information indicates that the original spillway of the dam was enlarged to its present width of 61 feet during a period between 1920 and 1930 with the intent to provide a spillway discharge capacity of 2100 cfs. A Commonwealth inspection report dated June 5, 1940, shows the spillway to be 62 feet wide and 5 feet deep.

(2) Embankment. No engineering data are available on the design of the embankment.

(3) Appurtenant Structures.

2.2 Construction. Other than the description of the dam and appurtenances included in Section 1.2a, no other information is available on the construction of the dam.

2.3 Operation. There are no formal operating records maintained for the dam. However, according to the available correspondence, the dam was overtopped during a flood in 1911 and major damage was incurred. According to water company personnel, it is probable that the dam may have also overtopped during the flood in July 1977.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER and the owner.

b. Adequacy

(1) Hydrology and Hydraulics. The available information consists of the design capacity of the spillway. This information is not considered to be sufficient to assess the adequacy of the spillway.

(2) Embankment. The available information includes no quantitative design data to evaluate the structural adequacy of the dam.

(3) Appurtenant Structures. The available information is not considered to be sufficient to assess the structural adequacy of the appurtenant structures.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Clover Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the spillway and the visible portions of the outlet works.

3. Evaluation of downstream area hazard potential.

The specific observations are illustrated in Plate 4.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the embankment is considered to be poor. The downstream slope of the dam was found to be very irregular, indicating that sloughing of the downstream face may have occurred at several locations in the past. At two locations on the downstream slope on the left side of the spillway discharge channel, depressions were found of what appeared to be sinkholes. These depressions may have been formed by deteriorating timber causing surface subsidence or by erosion during overtopping. Exposed rock in an area on the crest of the dam approximately 100 feet left of the spillway suggests that the embankment may have overtopped in the recent past. A seepage area was observed along the toe of the dam near the left abutment discharging approximately 10 to 20 gallons per minute. Accumulating silt in the swampy area below the seepage point suggests that internal erosion of the embankment may be occurring. The alignment of the upstream sheet piling was found to be irregular and several tie bars were loose, suggesting that the sheet piling has undergone significant deformations.

The crest of the dam was surveyed relative to the spillway crest elevation and the middle of the embankment was found to be on the order of 2 to 3 feet below the abutment levels. Plate 5 illustrates the longitudinal profile of the dam crest along the top of the upstream sheet piling and along the center of the embankment. The

downstream slope was surveyed at several locations and was found to range between 2.5H to 1V on the right side of the spillway to almost 1H to 1V near the left abutment.

c. Appurtenant Structures. The most significant condition noted in the spillway structures was the deteriorating concrete of the spillway discharge channel walls. The walls were partially collapsed in sections exposing the rock fill of the timber cribbing. This condition is considered to pose significant potential for erosion of the embankment in the event of large flows through the spillway. The visible portions of the outlet works consisted of the intake towers on the upstream side, valve chamber, and the downstream end of the outlet pipe. The intake towers have been abandoned and include no operating facilities. Flow through the outlet conduit is controlled by valves located at the downstream valve chamber. The downstream end of the blow-off pipe is within the streambed and is completely submerged.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered by woodlands. As can be determined from the dam site, no signs of landslide activity were found in the vicinity of the reservoir. A review of the regional geology is included in Appendix F.

e. Downstream Channel. Below the dam, the Clover Run flows through a narrow, steep valley for 3-1/2 miles and joins Mahoning Creek near the community of Big Run. A further description of the downstream conditions is included in Section 1.2d.

3.2 Evaluation. The condition of Clover Dam is considered to be poor. The crest of the dam and downstream slope are irregular and the center of the embankment is on the order of 2 to 3 feet below the abutment levels, suggesting that the embankment has undergone significant settlements or erosion. Considering these signs of distress and the fact that the structural strength of the timber crib construction is uncertain, further detailed investigation of the integrity of the embankment is recommended. The spillway and outlet facilities are also in need of repair and restoration.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the crest level of the uncontrolled spillway.

4.2 Maintenance of the Dam. The maintenance of the dam is considered to be poor. The downstream face of the dam is covered with trees and brush and debris. The condition of the dam suggests that no attempts are being made to maintain the embankment.

4.3 Maintenance of Operating Facilities. The intake towers have been abandoned and include no operating facilities. The only operable facility of the dam as it exists is the blow-off valve at a chamber at the downstream toe of the dam. The blow-off valve was operated by water company personnel during this inspection and was observed to be functional.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available via the water treatment plant approximately 4 miles from the dam. An approximately one-mile-long access road to the site is in poor condition and it is questionable whether the road would be passable during severe weather conditions for inspection of the facilities.

4.5 Evaluation. The dam is in poor condition and does not appear to be maintained. It is recommended that after repair and restoration of the facilities, formal maintenance plans be developed for continued maintenance. It is also recommended that the intake towers be rehabilitated to provide upstream control to the outlet pipes. The need for improving the accessibility of the dam should also be considered.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Clover Dam has a watershed of 6.2 square miles and impounds a reservoir with a surface area of 7.2 acres at normal pool level. The flood discharge facilities consist of a spillway located at the center of the embankment. The capacity of the spillway was estimated to be 1745 cfs relative to the freeboard available at a low point on the upstream steel sheet piling. The spillway capacity calculations are included in the computer output in Appendix D.

b. Experience Data. As previously stated, Clover Dam is classified as a small dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass half to full PMF. Considering the size of the dam in relationship to the downstream hazard potential, the lower limit of the range is considered to be applicable to this dam.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. The inflow hydrographs were found to have peak flows of 5338 and 10,676 cfs for 50 percent and full PMF, respectively. Computer input and a summary of computer output for the PMF analysis are included in Appendix D.

c. Visual Observations. No conditions were observed that would indicate the capacity of the spillway would be significantly reduced in the event of a flood. However, as described in Section 3.1c, a potential for erosion of the embankment exists in the event of large flows through the spillway.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir, and it was found that the spillway can pass about 15 percent of the PMF without overtopping the low spot on the upstream sheet piling. At 50 percent of the PMF, it was found that the dam would be overtopped for a duration of 10.3 hours with a maximum depth of 2.1 feet over the upstream sheet piling.

e. Spillway Adequacy. The spillway capacity was found to be less than the recommended spillway capacity of 50 percent of the PMF. Therefore, it is classified as inadequate. Further, a dam

breach analysis was conducted to determine if the downstream damage potential would significantly increase in the event of a dam failure. The dam breach analysis computer output is included in Appendix D. The results indicate that the change in flood stages would be less than one foot due to a dam failure, which was not considered to be a serious increase in the downstream damage potential due to dam failure. Therefore, the spillway capacity was not considered to be seriously inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations revealed various signs of distress consisting of indications of downstream slope movement, subsidence, and underseepage. Considering these signs of distress and the uncertain nature of the structural strength of the timber crib construction, further detailed investigation of the integrity of the embankment is recommended.

(2) Appurtenant Structures. The spillway structures were found to be seriously deteriorated and in need of repair and restoration. The manner in which the outlet pipe through the embankment has been constructed is unknown. Because no design and construction information is available, the structural adequacy of the design of the outlet facilities could not be assessed. Therefore, during the detailed investigation of the dam, the structural details of the outlet pipe, such as presence of concrete encasement or cutoff collars, should be investigated and a means for installing an upstream control on the outlet pipe should be developed.

b. Design and Construction Data

(1) Embankment. No design and construction information is available to assess the structural adequacy of the embankment design.

(2) Appurtenant Structures. No design information is available to assess the structural adequacy of the appurtenant structures.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. A Commonwealth report indicates that the dam was enlarged in 1911 by the placement of additional fill on the downstream and upstream faces and the crest of the dam.

e. Seismic Stability. In view of the concerns that exist relative to the static stability of the dam, the seismic stability of the dam is also considered to be questionable. Therefore, the seismic stability of the dam should be assessed in conjunction with further investigation and evaluation of the embankment.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Clover Dam is in poor condition. In view of the presence of numerous downstream slope irregularities and indications of subsidence and settlement, concern exists as to the continued stability of the dam. The dam is therefore classified to be unsafe/nonemergency. Detailed investigation of the embankment as an impounding structure is recommended. It is also recommended that in conjunction with the detailed investigation of the dam, the structural condition of the outlet facilities should be reevaluated and the intake towers should be repaired and restored.

The spillway capacity was evaluated according to the recommended procedure and was found to pass approximately 15 percent of PMF, which is less than the recommended spillway capacity of one-half PMF. Therefore, the spillway was classified to be inadequate. However, because it was found that the downstream flood stages would not be significantly increased in the event of a dam failure, the spillway was not considered to be seriously inadequate.

b. Adequacy of Information. Available information, in conjunction with visual observations and the previous experience of the inspectors, is considered to be sufficient to make the following recommendations.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. It is recommended that the dam and appurtenant structures should be investigated by a professional engineer experienced in the design and construction of dams to more accurately ascertain the consequences of the observed conditions and the overall integrity of the dam and to develop plans for remedial measures and providing adequate spillway capacity.

7.2 Recommendations/Remedial Measures.

It is recommended that the following recommendations be implemented immediately or on a continuing basis:

1. The owner should immediately retain a professional engineer experienced in the design and construction of dams for detailed evaluation of the dam and spillway facilities to prepare and execute plans for:

a. Evaluating the structural integrity of the embankment in view of the design features and the observed conditions;

b. Initiating additional detailed hydrologic and hydraulic studies to more accurately ascertain the spillway capacity and to determine the nature and extent of improvements required to provide adequate spillway capacity; and

c. Repair and restoration of the intake towers to provide upstream control to the outlet pipes through the embankment.

The detailed evaluation of the dam should include, but not be limited to, subsurface investigation, material testing, instrumentation, and stability and seepage analyses. In conjunction with the detailed investigation, the crest of the dam should be surveyed and filling of the low areas along the crest of the dam should be considered.

2. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

3. The dam and appurtenant structures should be inspected regularly and a formal maintenance manual should be developed for future maintenance of the dam.

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Clover Dam COUNTY Jefferson STATE Pennsylvania ID# NDI I.D. PA-420
DER I.D. 33-4

TYPE OF DAM Timber Crib Earth Structure HAZARD CATEGORY High

DATE(S) INSPECTION April 22, 1980 WEATHER Sunny TEMPERATURE 60s

POOL ELEVATION AT TIME OF INSPECTION 1555 M.S.L. TAILWATER AT TIME OF INSPECTION 1525± M.S.L.

INSPECTION PERSONNEL:

B. Erel
W. T. Chan

REVIEW INSPECTION PERSONNEL:
(April 30, 1980)

E. D'Appolonia
L. D. Andersen
J. H. Poellot

OWNER'S REPRESENTATIVE:

Mr. W. H. McAdams, Divison Engineer
Mr. R. A. Dami, Director,
Risk and Materials Management
Mr. W. B. Bruso, District Manager
Mr. R. L. Alling, Operation Superintendent

B. Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	The downstream face of the dam is very irregular, suggesting that the embankment may have significantly moved in the past.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	(See note above.)	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 5 for the dam crest profile.	
RIPRAP FAILURES	(Not applicable. The upstream face of the dam is protected by steel sheet piling.)	

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	A seepage point and swampy area is located near the left abutment. See Plate 4 for location.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE 1
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet pipe is a 20-inch cast-iron steel pipe.	
INTAKE STRUCTURE	There are two intake towers located on the upstream side of the embankment. The towers have been abandoned and the operating facilities have been dismantled.	
OUTLET STRUCTURE	None	
OUTLET CHANNEL	Outlet pipe directly discharges into the stream.	
EMERGENCY GATE	Flow through the 20-inch outlet pipe is controlled by a valve located at the downstream toe. The valve was operated by water company personnel and was observed to be functional.	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In fair condition.	
APPROACH CHANNEL	Lake	
DISCHARGE CHANNEL	The walls of the concrete discharge channel have seriously deteriorated.	
BRIDGE AND PIERS	There is a pedestrian bridge with one pier across the spillway.	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable	
APPROACH CHANNEL	Not applicable	
DISCHARGE CHANNEL	Not applicable	
BRIDGE PIERS	Not applicable	
GATES AND OPERATION EQUIPMENT	Not applicable	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle to moderately steep. No significant shoreline erosion was noted.	
SEDIMENTATION	Unknown	
UPSTREAM RESERVOIRS	None	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	There is a scar on the left side of the spillway in the downstream channel. See Plate 4 for location.	
SLOPES	No features pertinent to the safety of the dam.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	A water treatment plant is located 2-1/2 miles downstream from the dam. The community of Big Run is located 3-1/2 miles downstream. Population: approximately 10.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Clover Dam

ID# NDI I.D. PA-420
DER I.D. 33-4

ITEM	REMARKS
AS-BUILT DRAWINGS	Available in Commonwealth files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was constructed in 1896 by the Punxsatawney Water Company.
TYPICAL SECTIONS OF DAM	See Plate 2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	Not available

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not maintained
DESIGN REPORTS	None prepared
GEOLOGY REPORTS	None prepared
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None prepared
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None conducted

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	The original dam, which was built in 1896, was enlarged in 1912. The existing spillway was constructed during the period between 1925 and 1930.
HIGH POOL RECORDS	Not recorded

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	The dam was overtopped in 1911, incurring significant damage.
MAINTENANCE OPERATION RECORDS	Not maintained
SPILLWAY PLAN SECTIONS DETAILS	See Plate 2.
OPERATING EQUIPMENT PLANS AND DETAILS	Not available

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 6.2 square miles (woodlands)

ELEVATION, TOP OF NORMAL POOL AND STORAGE CAPACITY: 1555 (60 acre-feet)

ELEVATION, TOP OF FLOOD CONTROL POOL AND STORAGE CAPACITY: 1559.4 (101 acre-feet)

ELEVATION, MAXIMUM DESIGN POOL: 1559.4 (measured low spot)

ELEVATION, TOP OF DAM: 1559.4 (measured low spot)

SPILLWAY:

a. Elevation 1555

b. Type Rectangular overflow section

c. Width 61 feet (perpendicular to flow)

d. Length 60± feet (length of spillway discharge channel)

e. Location Spillover Adjacent to spillway

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 20-inch cast-iron pipe

b. Location Left of spillway

c. Entrance Inverts Unknown

d. Exit Inverts 1520±

e. Emergency Drawdown Facilities 20-inch outlet pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

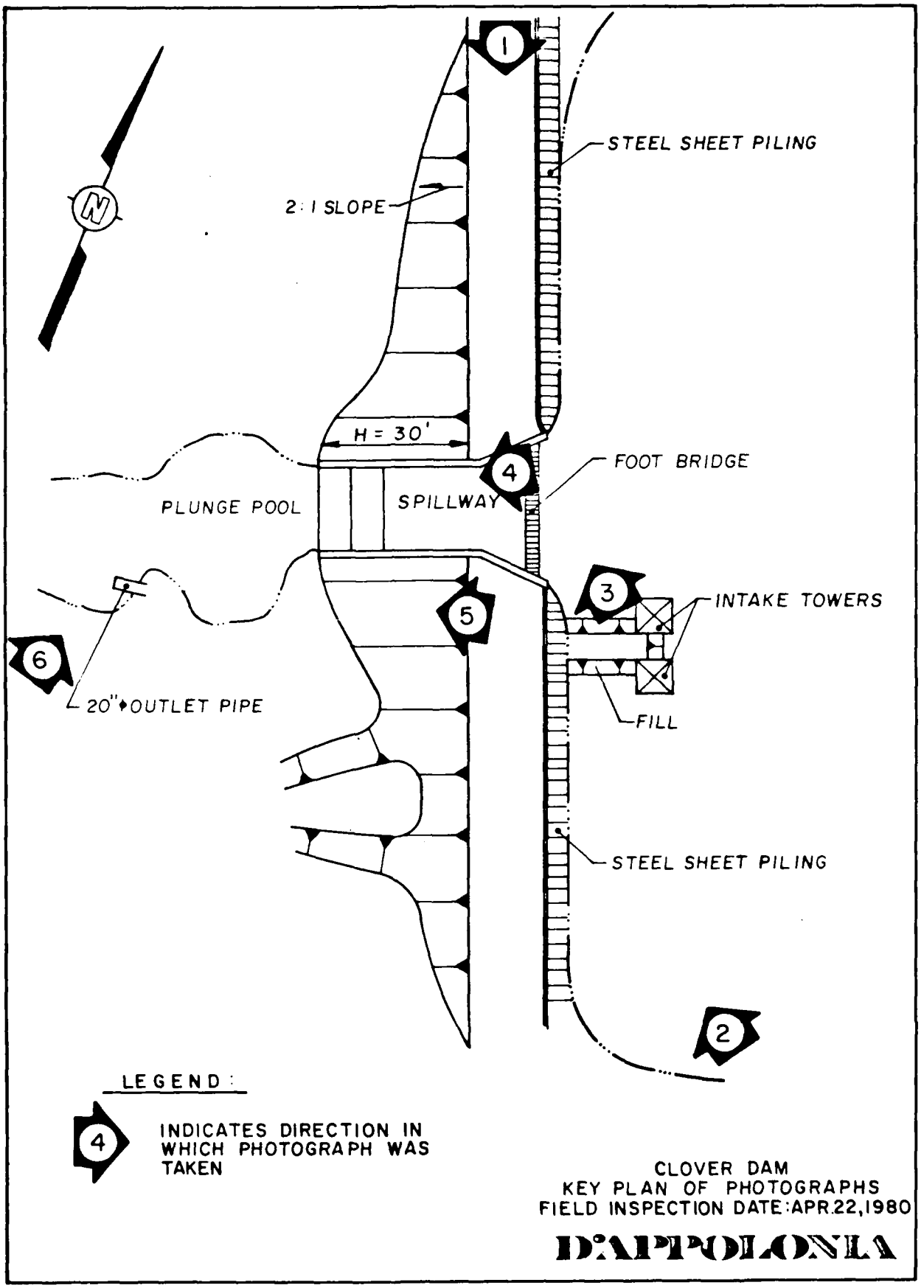
MAXIMUM NONDAMAGING DISCHARGE: 1750± (spillway capacity)

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
CLOVER DAM
NDI I.D. PA-420
DER I.D. 33-4
APRIL 22, 1980

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking east).
2	Upstream face steel sheet piling. (Intake tower in upper righthand corner: abandoned.)
3	Spillway crest.
4	Spillway plunge pool.
5	Outlet pipe valve chamber.
6	Downstream end of outlet pipe (pipe submerged).



CLOVER DAM
KEY PLAN OF PHOTOGRAPHS
FIELD INSPECTION DATE: APR. 22, 1980

D'APPOLONIA

Photograph No. 1

Crest (looking east).

Photograph No. 2

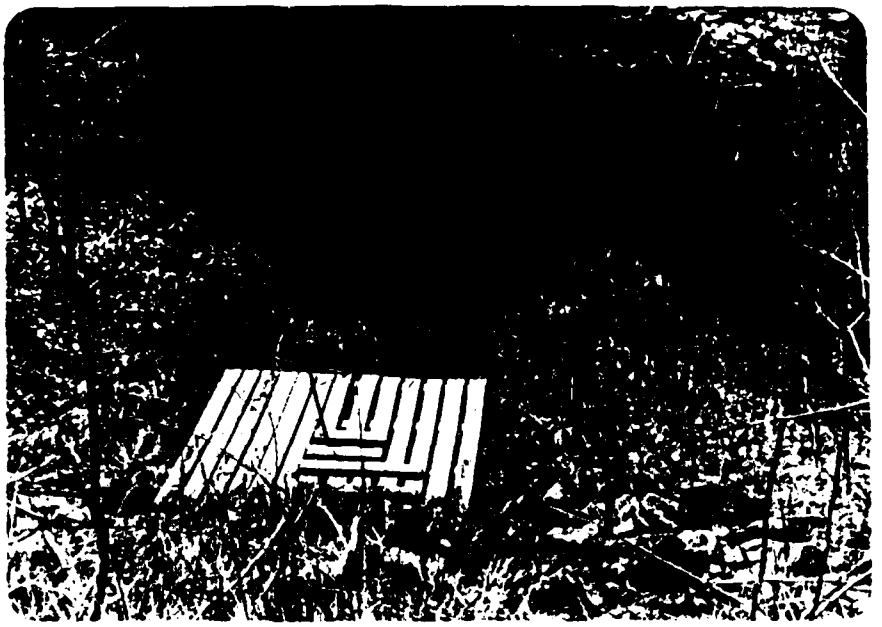
[illegible] steel sheet piling. (Intake tower [illegible] righthand corner: abandoned.)

Photograph No. 3

Spillway crest.

Photograph No. 4

Spillway crest.



Photograph No. 5

Outlet pipe valve chamber.

Photograph No. 6

Downstream end of outlet pipe (pipe submerged).

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Clover Dam (NDI I.D. PA-420)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.5 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Lake	Dam			
Drainage Area (square miles)	6.72	-			
Cumulative Drainage Area (square miles)	6.72	6.72			
Adjustment of PMF for Drainage Area (%)[2]	(ZONE 7)				
6 Hours	102	-			
12 Hours	120	-			
24 Hours	130	-			
48 Hours	140	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[3]	24	-			
C_p/C_t[4]	0.45/1.6	-			
L (miles)[5]	4.2	-			
L_{ca} (miles)[5]	1.8	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	2.94	-			
Spillway Data					
Crest Length (ft)	-	61			
Freeboard (ft)	-	4.4			
Discharge Coefficient	-	3.1[6]			
Exponent	-	1.5			

[1] Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

[2] Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

[3] Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

[4] Snyder's Coefficients.

[5] L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

[6] Assumed based on field observations.

STORAGE VS. ELEVATION

ELEVATION	ΔH, FEET	AREA (ACRES)[1]	ΔVOLUME (ACRE-FEET)[2]	STORAGE (ACRE-FEET)
1528[3]	27	-	64.5[4]	0
1555[5]		7.3		64.5
	5		41.1	
1560		9.2		105.6
	20		278.8	
1580		19.3		384.4

[1] Planimetered from USGS maps.

[2] $\Delta Volume = \Delta H/3 \ (A_1 + A_2 + \sqrt{A_1 A_2})$.

[3] Estimated based on structural height of dam.

[4] From PennDER files.

[5] Normal pool elevation.

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       SNYDER UNIT HYDROGRAPH, DOWNSTREAM FLOOD ROUTING, AND OVERTOPPING ANALYSES
    2                A2       CLOVER DAM, INDIANA COUNTY NDI-I D PA 420                PROJECT NO 79-543-19
    3                A3       FOR 15%, 30%, 50%, AND 100% PMF
    4                B    300        0       10        0        0        0        0        0       -4        0
    5                B1     5
    6                J      1        4        1
    7                J1  0 15     0 30     0 50     1 00
    8                K      0        1                                                  1
    9                K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO CLOVER DAM
   10                M      1        1     6 72             6 72                                      1
   11                P              23 5      102      120      130      140
   12                T                                                                1 0      05             0 0017
   13                W    2 94     0 45
   14                X    -1 0    -0 05     2 0
   15                K      1        2                                                  1
   16                K1       ROUTING FLOW THROUGH CLOVER DAM (NDI-I D PA 420)CONSIDERING SHEET PILES
   17                Y                                          1        1
   18                Y1     1                                                  -1555 0
   19                $S    0 0     64 5    105 6    384 4
   20                $E1528 0  1555 0  1560 0  1580 0
   21                $$1555 0   61 00     3 10      1 5
   22                $D1559 4     3 10      1 5    520 0
   23                $L   50 0     75 0    145 0    220 0    290 0    390 0    440 0    480 0    505 0    520 0
   24                $V1559 4  1559 7  1559 8  1560 3  1560 5  1560 6  1561 6  1561 7  1562 5  1562 6
   25                K      1        3                                                  1
   26                K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 0-1(DAM TO MILE 0 3)
   27                Y                                          1        1
   28                Y1     1
   29                Y6 0 045   0 045    0 045  1500 0  1560 0  1584 0 0 01768
   30                Y7    0 0  1560 0   160 0  1540 0   420 0  1520 0   840 0  1500 0   860 0  1500 0
   31                Y71005 0  1520 0  1160 0  1540 0  1320 0  1560 0
   32                K      1        4                                                  1
   33                K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 1-2(MILE 0 3 TO 1 1)
   34                Y                                          1        1
   35                Y1     1
   36                Y6 0 045   0 045    0 045  1420 0  1480 0  4224 0 0 01894
   37                Y7    0 0  1480 0   300 0  1460 0   620 0  1440 0  1510 0  1420 0  1530 0  1420 0
   38                Y71560 0  1440 0  1590 0  1460 0  1620 0  1480 0
   39                K      1        5                                                  1
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```
40              K1      CHANNEL ROUTING USING MODIFIED PULS:REACH 2-3(MILE 1.1 TO 2 3)
41              Y                                       1       1
42              Y1      1
43              Y6 0.045   0 045   0 045  1320.0  1380.0  6336.0 0.01578
44              Y7   0.0  1380.0    40.0  1360.0    80.0  1340.0   440.0  1320.0   460.0  1320.0
45              Y7 590.0  1340.0   790.0  1360.0   900.0  1380.0
46              K       1       6                                       1
47              K1      CHANNEL ROUTING USING MODIFIED PULS REACH 3-4(MILE 2.3 TO 2.9)FILTRATION
48              Y                                       1       1
49              Y1      1
50              Y6 0.045   0 045   0 045  1300.0  1360.0  3168.0 0.00631
51              Y7   0.0  1360.0   100.0  1340.0   260.0  1320.0   850.0  1300.0   980.0  1300.0
52              Y71140.0  1320.0  1170.0  1340.0  1200.0  1360.0
53              K       1       7                                       1
54              K1      CHANNEL ROUTING USING MODIFIED PULS:REACH 4-5(MILE 2.9 TO 4 0)BIG RUN
55              Y                                       1       1
56              Y1      1
57              Y6 0.045   0 045   0 045  1280.0  1340.0  5808.0 0.00344
58              Y7   0.0  1340.0   230.0  1320.0   460.0  1300.0  1030.0  1280.0  1150.0  1280.0
59              Y71260.0  1300.0  1440.0  1320.0  1600.0  1340.0
60              K      99
```

COMPUTER INPUT OVERTOPPING ANALYSIS
(CONTINUED)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .15	RATIO 2 .30	RATIO 3 .50	RATIO 4 1.00
HYDROGRAPH AT	1	6.72	1	1601	3203.	5338.	10676.
		(17.40)		(45.34)(	90.69)(	151.15)(	302.30)(
ROUTED TO	2	6.72	1	1596.	3202.	5340.	10680.
		(17.40)		(45.19)(	90.67)(	151.20)(	302.42)(
ROUTED TO	3	6.72	1	1596.	3200.	5339.	10681.
		(17.40)		(45.20)(	90.62)(	151.17)(	302.45)(
ROUTED TO	4	6.72	1	1591.	3197.	5331.	10662.
		(17.40)		(45.04)(	90.54)(	150.96)(	301.91)(
ROUTED TO	5	6.72	1	1587.	3188.	5315.	10647.
		(17.40)		(44.93)(	90.27)(	150.51)(	301.50)(
ROUTED TO	6	6.72	1	1581.	3183.	5306.	10636.
		(17.40)		(44.76)(	90.13)(	150.24)(	301.18)(
ROUTED TO	7	6.72	1	1550.	3158.	5271.	10585.
		(17.40)		(43.89)(	89.44)(	149.26)(	299.73)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1555.00	1555.00	1559.40
STORAGE	65.	65.	101.
OUTFLOW	0.	0.	1745.

RATIO OF PMF	MAXIMUM RESERVOIR W S ELEV	MAXIMUM DEPTH OVER DAM (1)	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	1559.15	0.00	99.	1596	0.00	42.83	0.00
.30	1560.66	1.26	115.	3202	6.33	42.67	0.00
.50	1561.51	2.11	127.	5340.	10.33	42.67	0.00
1.00	1562.92	3.52	146.	10680.	12.83	42.67	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1596.	1503.3	42.83
.30	3200.	1504.2	42.67
.50	5339.	1505.4	42.67
1.00	10681.	1507.3	42.67

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1591.	1422.6	43.00
.30	3197.	1423.6	42.83
.50	5331.	1424.4	42.83
1.00	10662.	1426.3	42.83

(1) Depth over sheet piling.

OVERTOPPING ANALYSIS SUMMARY

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1587.	1323.4	43.17
.30	3188.	1324.5	43.00
.50	5315.	1325.9	43.00
1.00	10647.	1327.8	42.83

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1581.	1301.8	43.33
.30	3183.	1303.3	43.17
.50	5306.	1304.1	43.00
1.00	10636.	1306.2	43.00

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1550.	1282.6	43.83
.30	3158.	1283.9	43.33
.50	5271.	1285.1	43.33
1.00	10585.	1287.4	43.17

OVERTOPPING ANALYSIS SUMMARY
(CONTINUED)

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*******  *  ***  **********  **
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
     1              A1       SNYDER UNIT HYDROGRAPH, DOWNSTREAM FLOOD ROUTING, AND DAM BREACH ANALYSES
     2              A2       CLOVER DAM, INDIANA COUNTY NDI-I D PA 420                    PROJECT NO 79-543 19
     3              A3       FOR 15%, 30%, 50%, AND 100% PMF
     4              B     300        0       10        0        0        0        0        0       -4        0
     5              B1      5
     6              J       1        4        1
     7              J1   0 15     0 30     0 50     1 00
     8              K       0        1                                          1
     9              K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO CLOVER DAM
    10              M       1        1     6 72             6 72                                        1
    11              P              23 5      102      120      130      140
    12              T                                                        1 0       05            0 0017
    13              W    2 94     0 45
    14              X    -1.0    -0 05      2 0
    15              K       1        2                                          1
    16              K1       ROUTING FLOW THROUGH CLOVER DAM (NDI-I D PA 420)CONSIDERING SHEET PILES
    17              Y                                 1        1
    18              Y1      1                                          -1555 0
    19              $S    0 0     64 5    105 6    384 4
    20              $E1528 0   1555 0   1560 0   1580 0
    21              $$1555 0    61 00     3 10     1 5
    22              $D1559 4     3 10      1 5     520 0
    23              $L   50 0     75 0     145 0    220 0    290 0    390 0    440 0    480 0    505 0    520 0
    24              $V1559 4   1559 7   1559 8   1560 3   1560 5   1560 6   1561 6   1561 7   1562 5   1562 6
    25              $B  100 0      1 0   1528 0      0 5   1555 0   1560 4
    26              K       1        3                                          1
    27              K1       CHANNEL ROUTING USING MODIFIED PULS REACH 0-1(DAM TO MILE 0 3)
    28              Y                                 1        1
    29              Y1      1
    30              Y6 0.045    0 045    0 045   1500 0   1560 0   1584 0 0 01768
    31              Y7    0 0   1560 0    160 0   1540 0    420 0   1520 0    840 0   1500 0    860 0   1500 0
    32              Y71005 0    1520 0   1160 0   1540 0   1320 0   1560 0
    33              K       1        4                                          1
    34              K1       CHANNEL ROUTING USING MODIFIED PULS REACH 1-2(MILE 0 3 TO 1 1)
    35              Y                                 1        1
    36              Y1      1
    37              Y6 0 045    0 045    0 045   1420 0   1480 0   4224 0 0 01894
    38              Y7    0 0   1480 0    300 0   1460 0    620 0   1440 0   1510 0   1420 0   1530 0   1420 0
    39              Y71560 0    1440 0   1590 0   1460 0   1620 0   1480 0
    40              K       1        5                                          1
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```
41          KK      CHANNEL ROUTING USING MODIFIED PULS REACH 2-3(MILE 1 1 TO 2 3)
42          KY                                      1       1
43          KY1     1
44          KY6 0 045   0 045   0 045   1320 0  1360 0  [illegible]
45          KY7   0 0   1380 0    40 0   1360 0    [illegible]
46          KY7 590 0   1340 0   790 0   1360 0   960 0   1320 0
47          KK      1       6                                       1
48          KK      CHANNEL ROUTING USING MODIFIED P   REACH [illegible]
49          KY                                      1       1
50          KY1     1
51          KY6 0 045   0 045   0 045   1300 0  1360 0  3168 0 0 00631
52          KY7   0 0   1360 0   100 0   1340 0   260 0   1320 0   850 0   1300 0   980 0   1300 0
53          KY71140 0   1320 0  1170 0   1340 0  1200 0   1360 0
54          KK      1       7                                       1
55          KK      CHANNEL ROUTING USING MODIFIED PULS REACH 4-5(MILE 2 9 TO 4 0)BIG RUN
56          KY                                      1       1
57          KY1     1
58          KY6 0 045   0 045   0 045   1280 0  1340 0  5808 0 0 00344
59          KY7   0 0   1340 0   230 0   1320 0   460 0   1300 0   1030 0   1280 0   1150 0   1280 0
60          KY71260 0   1300 0  1440 0   1320 0  1600 0   1340 0
61          KK     99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIOS APPLIED TO FLOWS RATIO 3	RATIO 4
				15	30	50	1.00
HYDROGRAPH AT	1	6.72	1	1601.	5203.	5333.	10676.
		(17.40)	(	45.34)(	90.69)(	151.15)(	302.30)(
ROUTED TO	2	6.72	1	1596.	5792.	6130.	10679.
		(17.40)	(	45.19)(	164.01)(	173.57)(	302.39)(
ROUTED TO	3	6.72	1	1596.	6021.	6477.	10682.
		(17.40)	(	45.20)(	170.51)(	183.42)(	302.47)(
ROUTED TO	4	6.72	1	1591.	5566.	6080.	10666.
		(17.40)	(	45.04)(	157.61)(	172.18)(	302.04)(
ROUTED TO	5	6.72	1	1587.	4982.	5446.	10651.
		(17.40)	(	44.93)(	141.08)(	154.22)(	301.61)(
ROUTED TO	6	6.72	1	1581.	4888.	5310.	10637.
		(17.40)	(	44.76)(	138.41)(	150.36)(	301.20)(
ROUTED TO	7	6.72	1	1550.	4297.	5274.	10588.
		(17.40)	(	43.89)(	121.68)(	149.34)(	299.83)(

[illegible] OF DAM BREACH ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1555.00	1555.00	1559.40
STORAGE	65	65	101.
OUTFLOW	0	0	1745

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	1559.15	0.00	99.	1596.	0.00	42.83	0.00
.30	1560.45	1.05	112.	8406.	1.49	41.93	41.67
.50	1560.54	1.14	113.	8748.	1.50	40.60	40.33
1.00	1560.48	1.08	112.	10679.	1.49	42.67	38.50

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	1596.	1503.3	42.83
.30	6021.	1505.8	42.00
.50	6477.	1506.0	40.67
1.00	10682.	1507.3	42.67

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	1591.	1422.6	43.00
.30	5566.	1424.5	42.17
.50	6080.	1424.7	40.83
1.00	10666.	1426.3	42.67

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1587	1323.4	43.17
.30	4982	1325.7	42.17
.50	5446	1326.0	41.00
1.00	10651	1327.8	42.83

PLAN 1 STATION 6

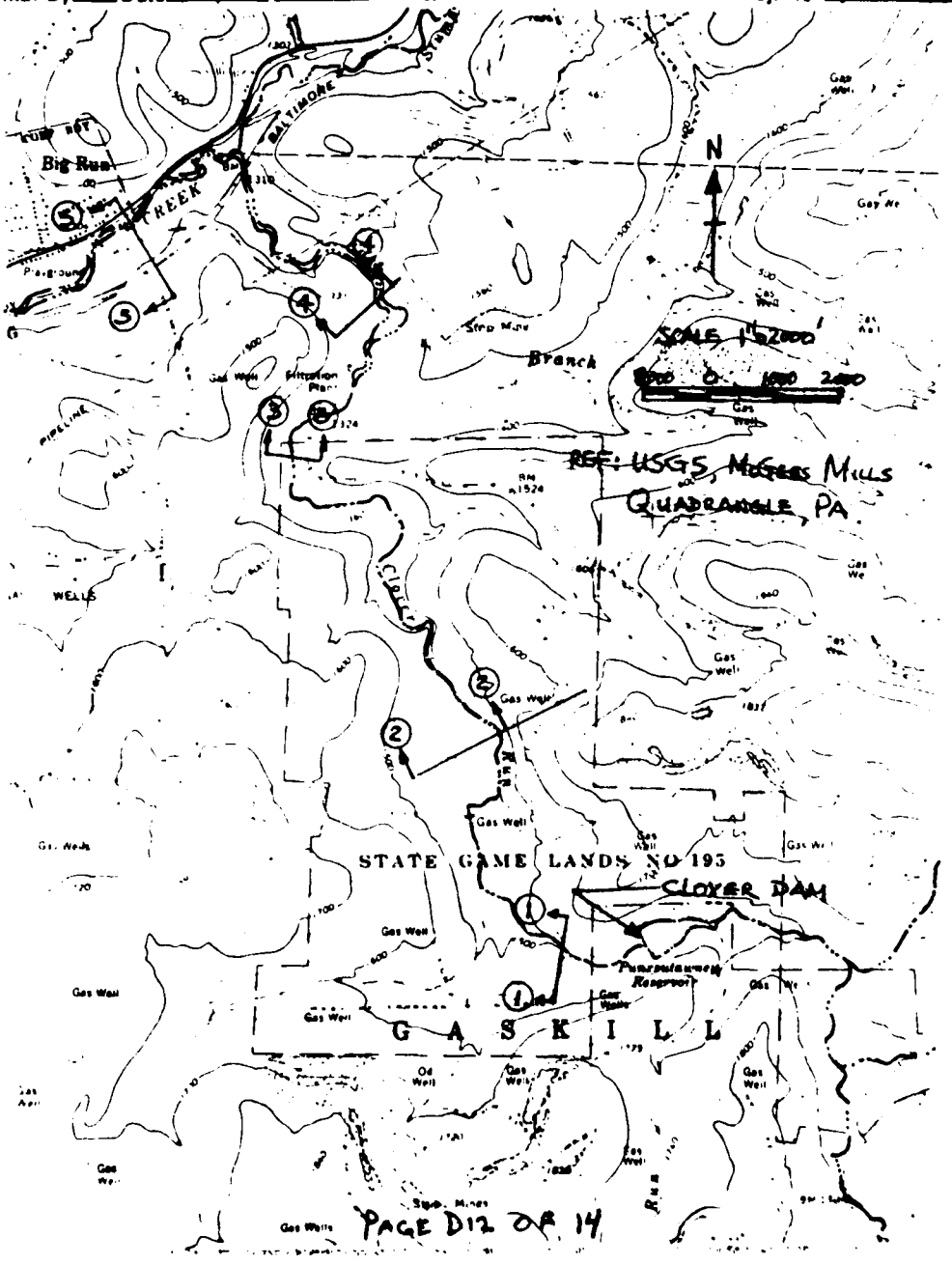
RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1581	1301.8	43.33
.30	4888	1304.0	42.33
.50	5310	1304.1	43.00
1.00	10687	1306.2	43.00

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
.15	1550	1282.6	43.83
.30	4297	1284.5	42.50
.50	5274	1285.1	43.33
1.00	10588	1287.4	43.17

D'APPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 5/29/80 Subject CLOVER DAM Sheet No. 1 of 1
Chkd. By ___ Date 5/29/80 D/S ROUTING Proj. No. TP-543-18

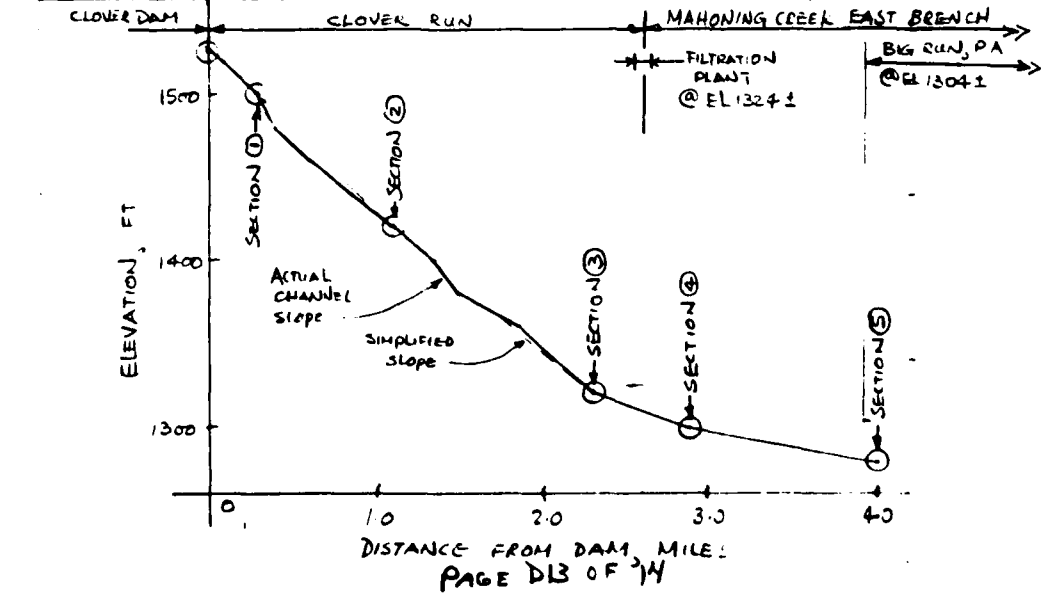


D'APPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 5/22/80 Subject CLOVER DAM Sheet No. 1 of 2
Chkd. By PE Date 5/28/80 D/S ROUTING Proj. No. 79-543-19

CHANNEL PROFILE AND CROSS SECTION OF CLOVER RUN & MAHONING CREEK EAST BRENCH

REACH	LOCATION	ELEVATION (USGS) FT	DISTANCE D/S FROM DAM MILES	SIMPLIFIED CHANNEL SLOPE %	REMARKS
0-1	TAILWATER	1528	≈0	$\frac{28}{1584}$ = 1.768%	
		1520	0.1		
	SECTION (1)	1500	0.3		
1-2		1480	0.4	$\frac{80}{4224}$ = 1.894%	
		1460	0.6		
		1440	0.85		
	SECTION (2)	1420	1.1		
2-3		1400	1.35		
		1380	1.5	$\frac{100}{6336}$ = 1.578%	
		1360	1.85		
		1340	2.05		
3-4	SECTION (3)	1320	2.3	$\frac{20}{3168}$ = 0.631%	FILTRATION PLANT
4-5	SECTION (4)	1300	2.9	$\frac{20}{5808}$ = 0.344%	BIG RUN, PA
	SECTION (5)	1280	4.0		



SUMMARY OF CHANNEL CROSS SECTION DATA

REACH 0-1	REACH 1-2	REACH 2-3	REACH 3-4	REACH 4-5
L = 1584'	L = 4224'	L = 6336'	L = 3168'	L = 5808'
S = 1.768%	S = 1.894%	S = 1.578%	S = 0.631%	S = 0.344%

SECTION ①		SECTION ②		SECTION ③		SECTION ④		SECTION ⑤	
DISTANCE	ELEVATION	DISTANCE	ELEVATION	DISTANCE	ELEVATION	DISTANCE	ELEVATION	DISTANCE	ELEVATION
0	1560	0	1480	0	1380	0	1360	0	1340
160	1540	300	1460	40	1360	100	1340	230	1320
420	1520	620	1440	80	1340	260	1320	460	1300
840	1500	1510	1420	440	1320	850	1300	1030	1280
860	1500	1530	1420	460	1320	980	1300	1150	1280
1005	1520	1560	1440	590	1340	1140	1320	1260	1300
1160	1540	1590	1460	790	1360	1170	1340	1440	1320
1320	1560	1620	1480	900	1380	1200	1360	1600	1340

NOTES (1) L and S are length & slope of reach between sections
(2) Distances for each section are measured from left to right, looking downstream.
(3) Assume channel bottom width of 20' minimum.
(4) Assume channel roughness coef. or Manning discharge coef $n = 0.045$ for all reaches.

APPENDIX E

PLATES

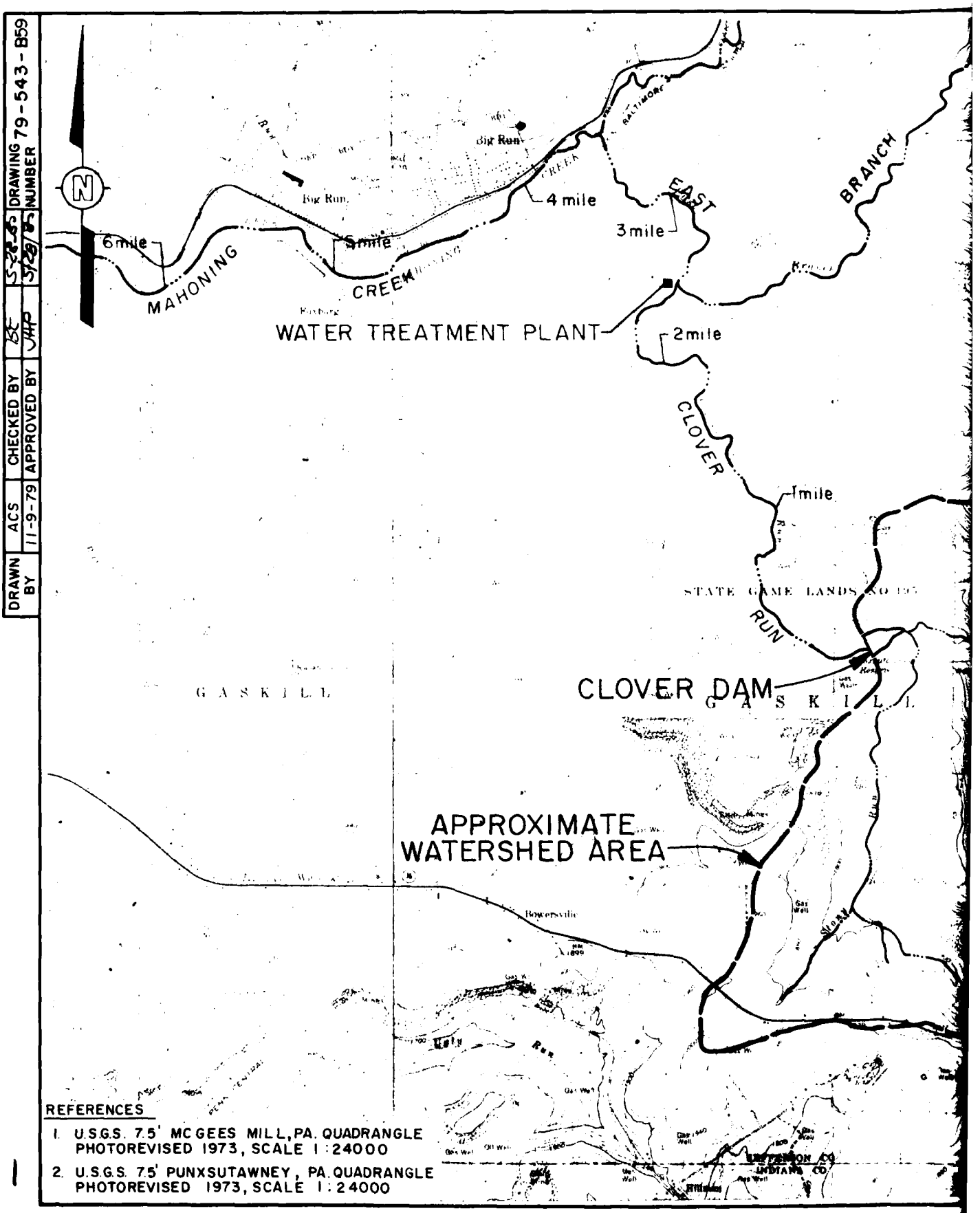
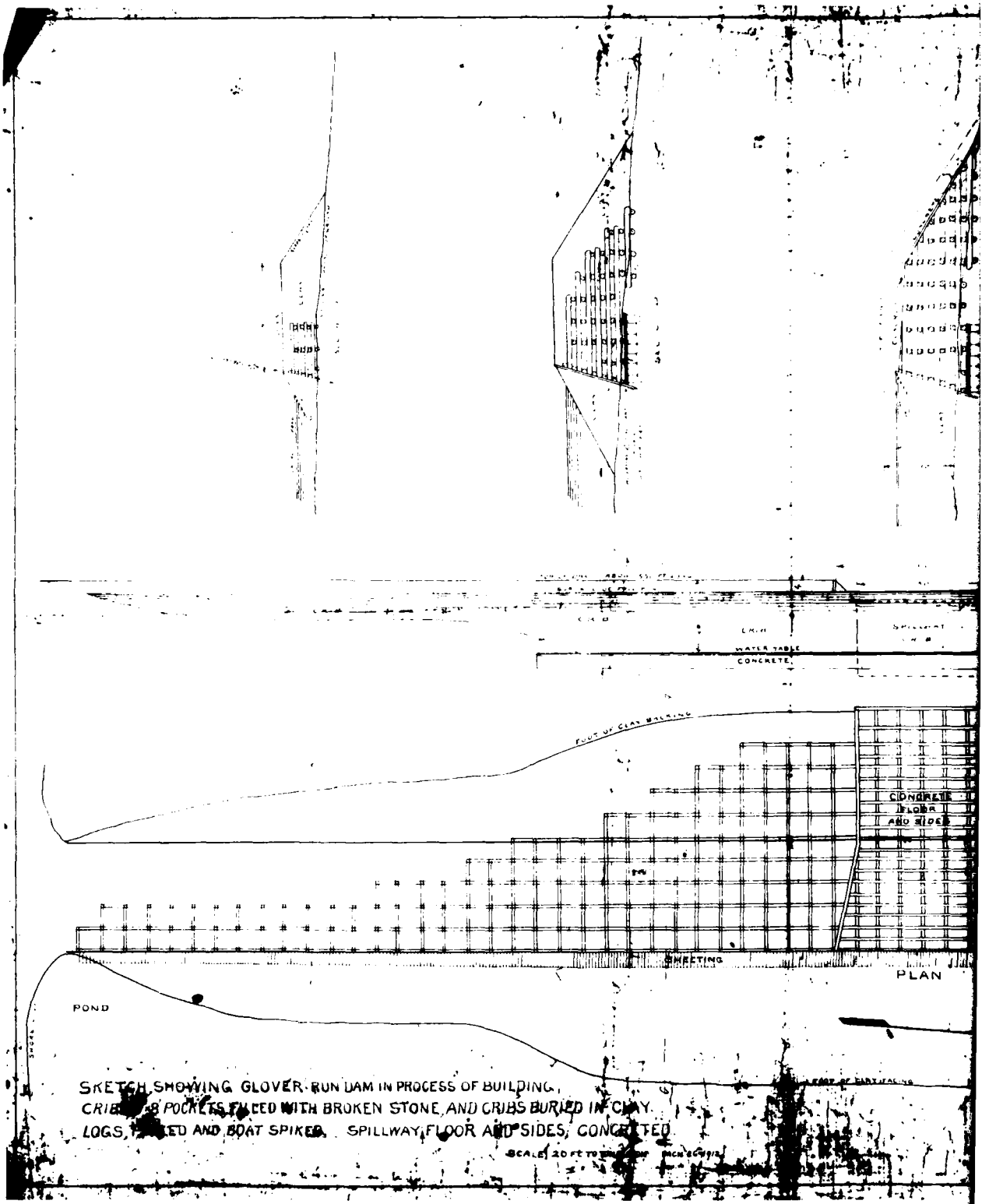

DRAWING NUMBER 79-543-B59
DRAWN BY ACS 11-9-79
CHECKED BY BC
APPROVED BY JHP
N
6mile
5mile
4 mile
3mile
2mile
1mile
MAHONING CREEK
EAST BRANCH
Big Run
WATER TREATMENT PLANT
CLOVER RUN
CLOVER DAM
STATE GAME LANDS NO 135
GASKILL
APPROXIMATE WATERSHED AREA
Bowersville
REFERENCES
1. U.S.G.S. 7.5' MC GEES MILL, PA. QUADRANGLE PHOTOREVISED 1973, SCALE 1:24000
2. U.S.G.S. 7.5' PUNXSUTAWNEY, PA. QUADRANGLE PHOTOREVISED 1973, SCALE 1:24000

PLATE 1

CLOVER DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	RSC	5-28-80	DRAWING NUMBER 79-543-B60
	5.28.80	APPROVED BY	JHP	5/28/80	



SKETCH SHOWING GLOVER RUN DAM IN PROCESS OF BUILDING.
CRIBS 8' POCKETS FILLED WITH BROKEN STONE, AND CRIBS BURIED IN CLAY.
LOGS, [illegible] AND BOAT SPIKED. SPILLWAY FLOOR AND SIDES, CONCRETED.
SCALE 20 FT TO [illegible] INCH

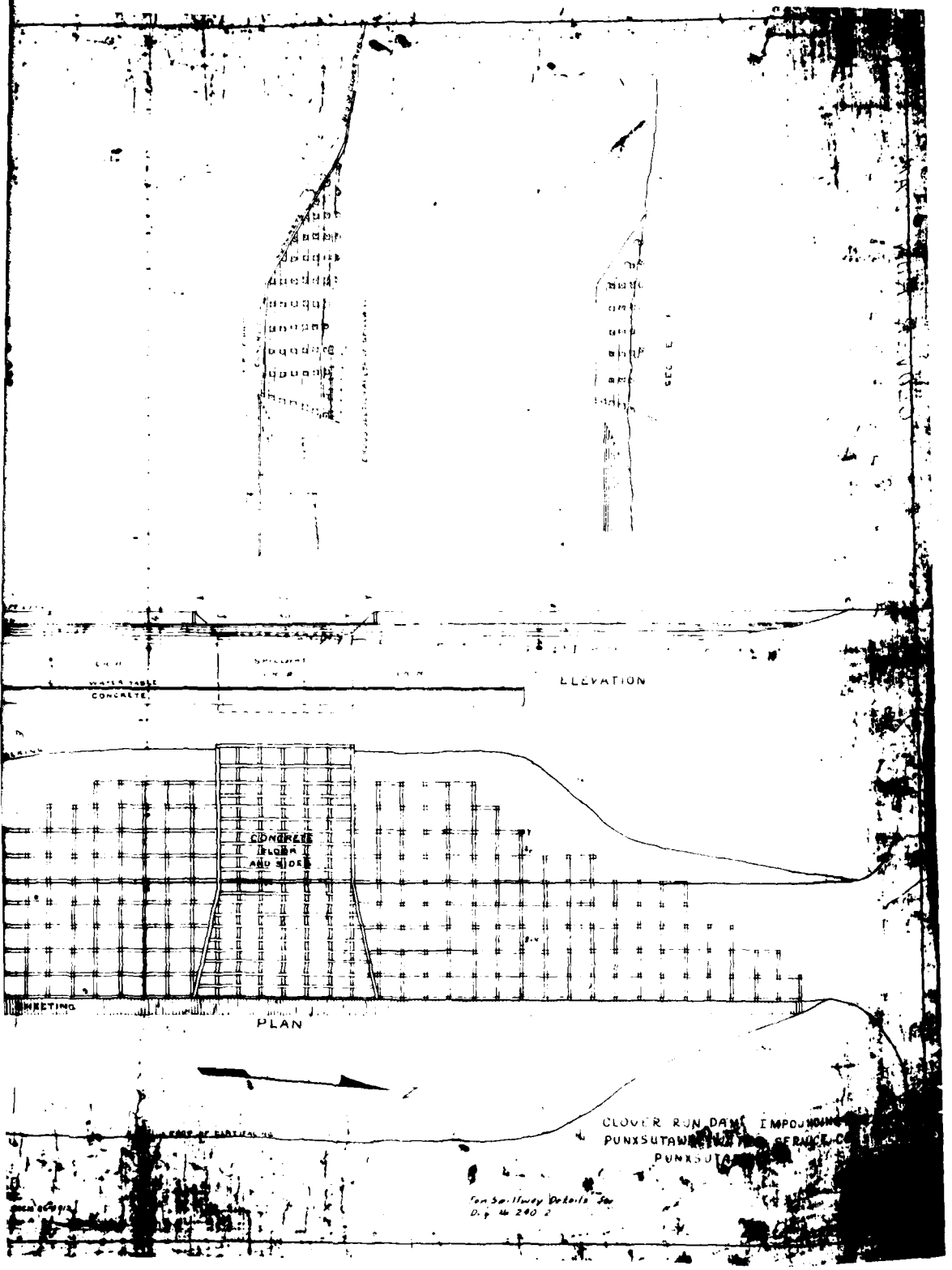
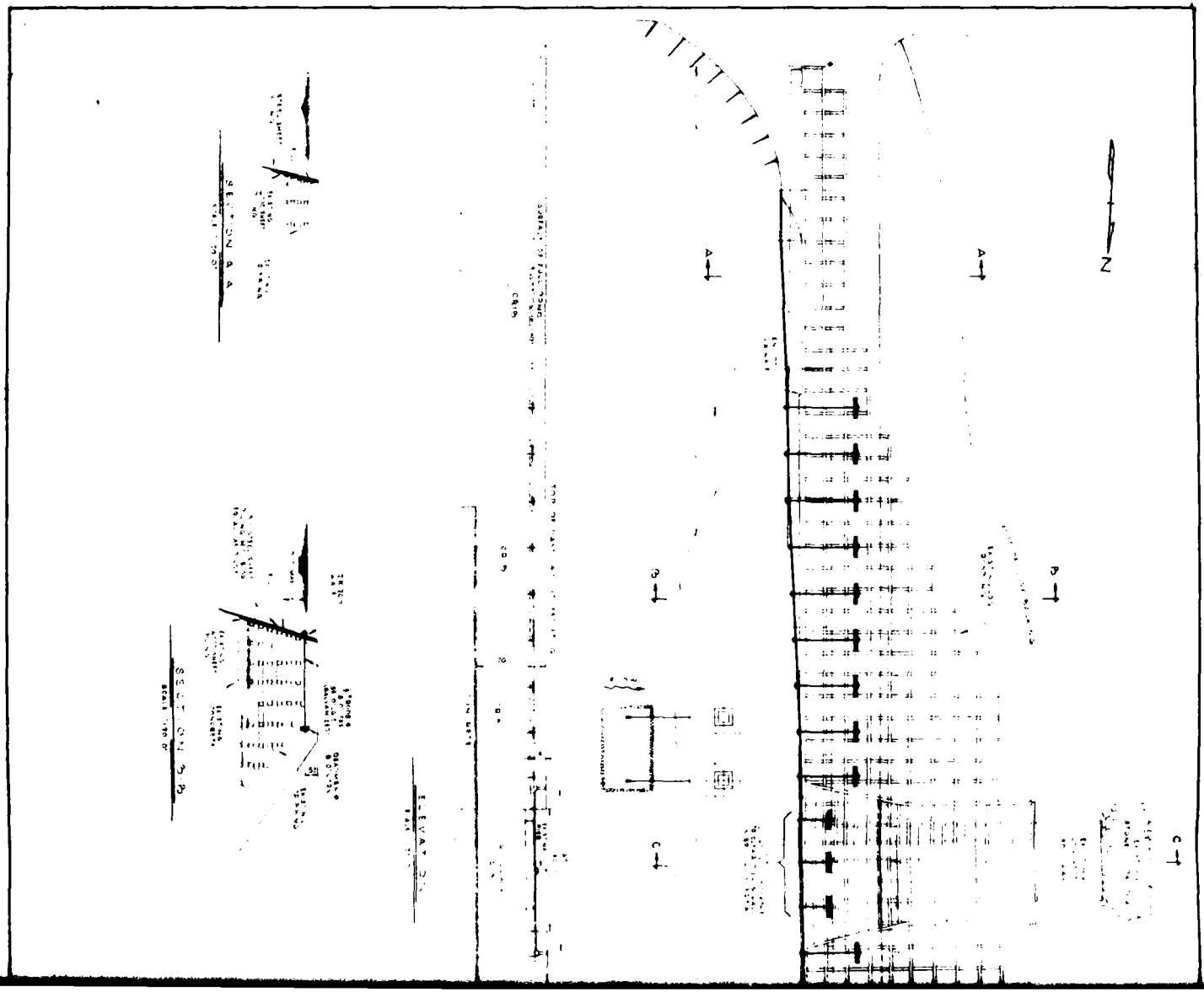


PLATE 2

D'APPOLONIA

DRAWN BY	ACS 5-28-80	CHECKED BY	JLP	5-28-80	DRAWING NUMBER	79-543-B61
		APPROVED BY	JLP	5/28/80		



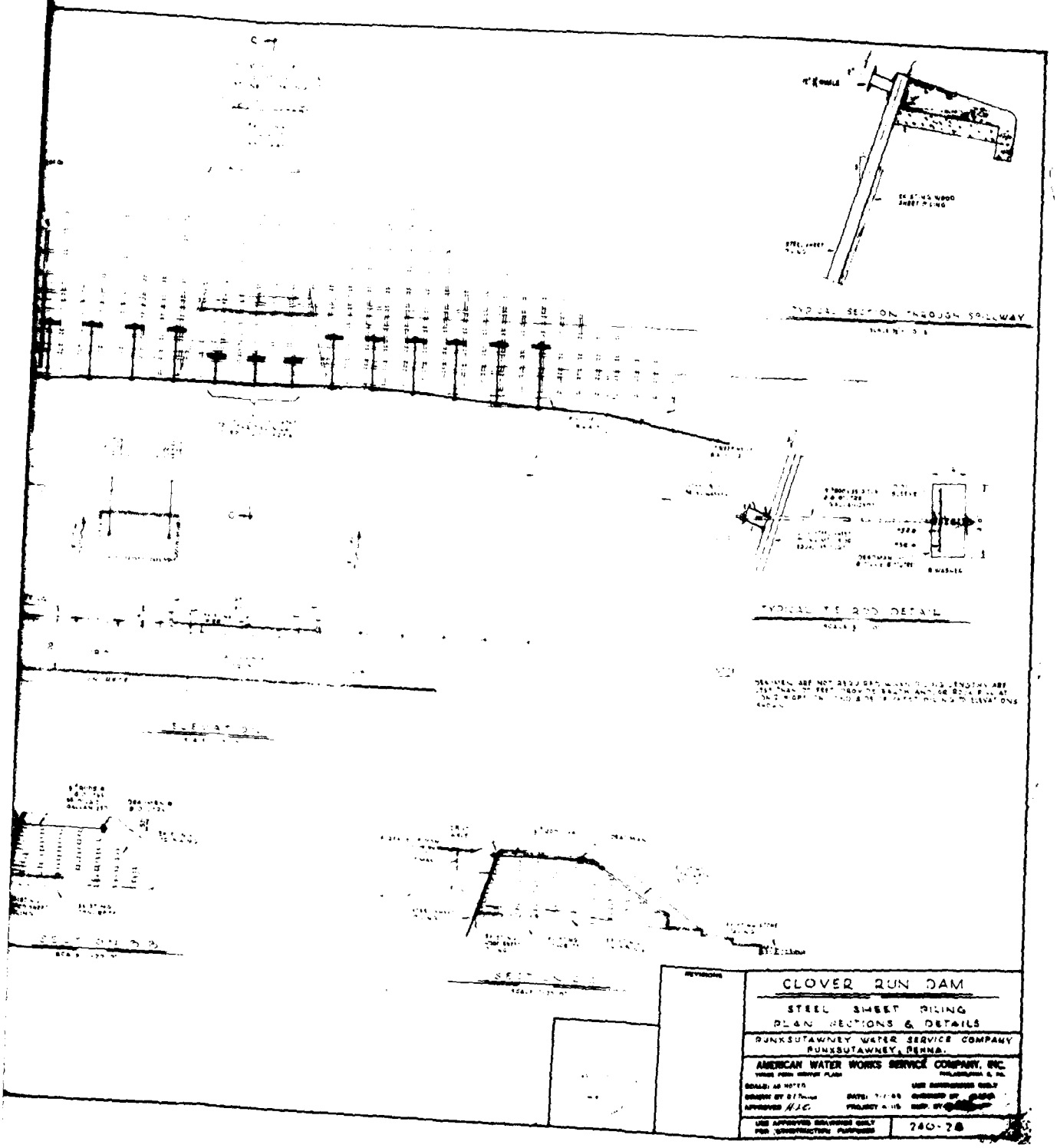
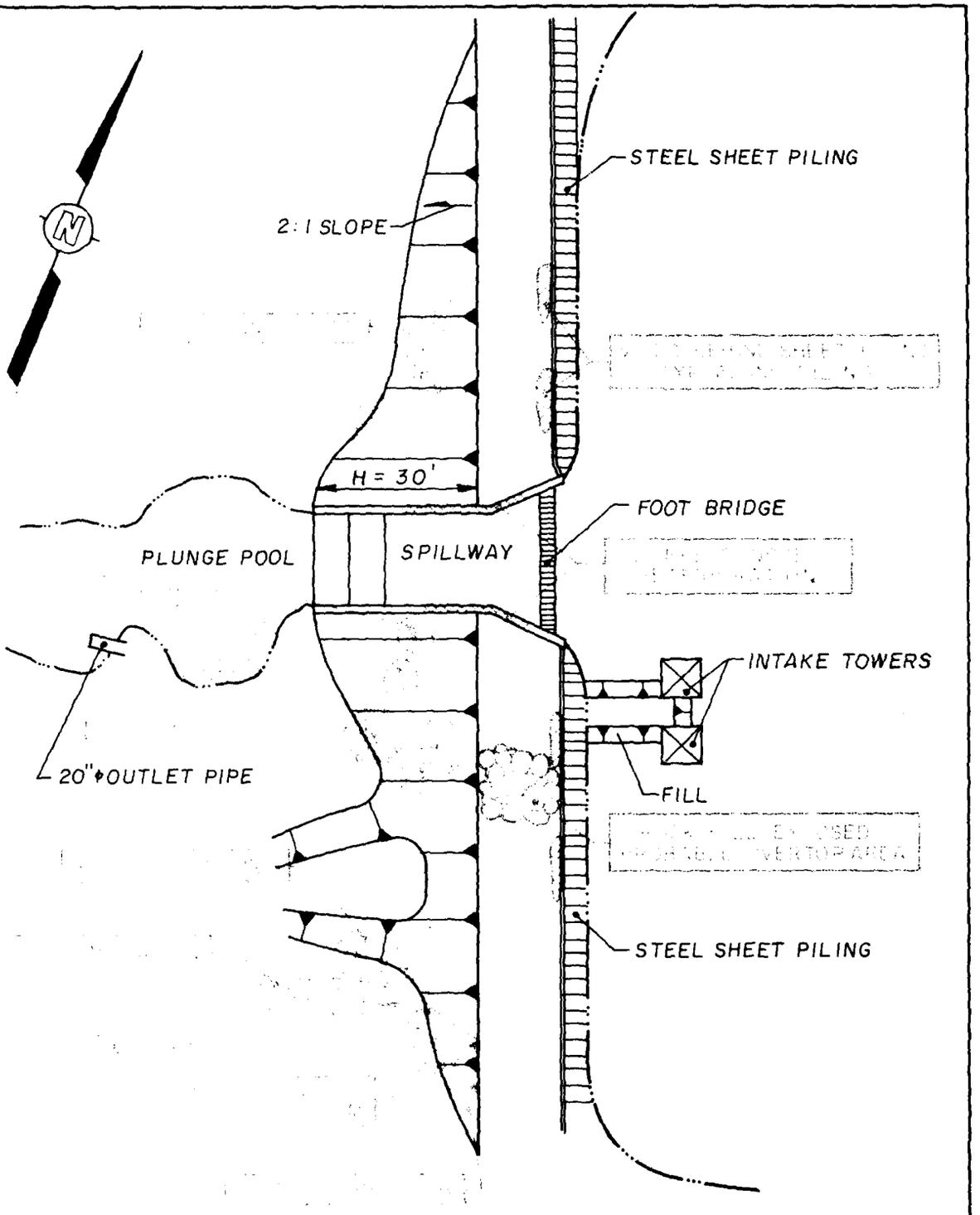


PLATE 3

DRAWN BY	CHECKED BY	DRAWING NUMBER
ACS		79-J43-A45
5-21-80	APPROVED BY	



NOTES:

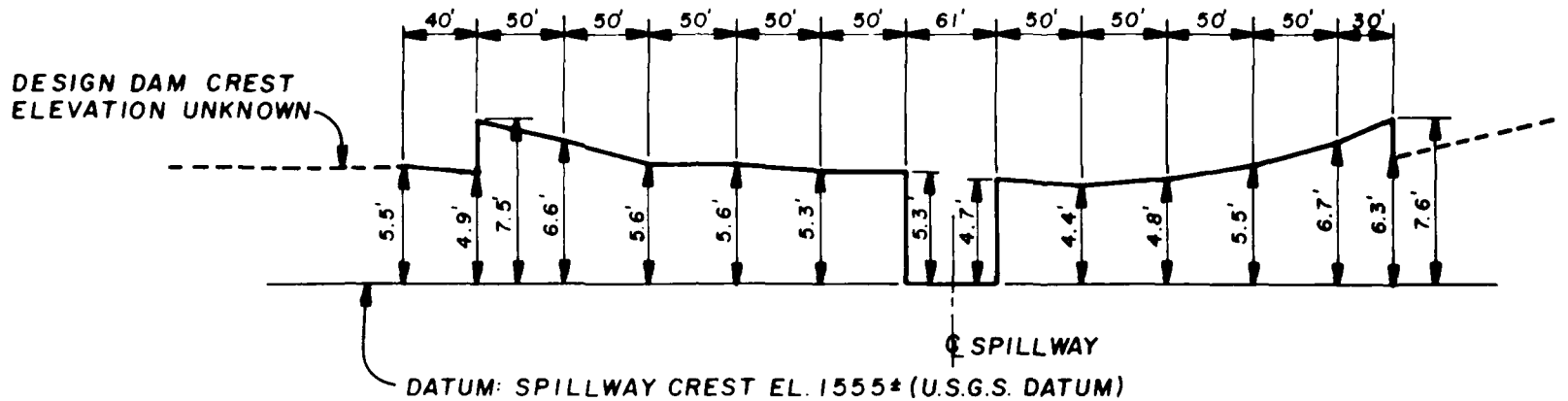
1. POOL LEVEL DATE OF INSPECTION: 01 FT. ABOVE SPILLWAY CREST

PLATE 4

CLOVER DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: APR. 22, 1980

D'APPOLONIA

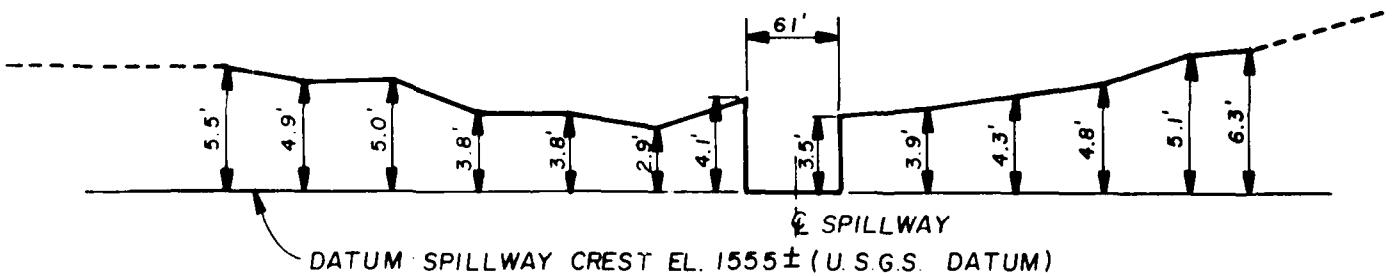
DRAWN BY	ACS	CHECKED BY	JSE	5-28-80	DRAWING NUMBER 79	13-A46
	5-28-80	APPROVED BY	JHP	9/28/32		



DAM CREST PROFILE

(ALONG TOP OF UPSTREAM SHEET PILING)

(LOOKING DOWNSTREAM)



DAM CREST PROFILE

(ALONG ℄ OF DAM CREST)

(LOOKING DOWNSTREAM)

NOTES:

1. DAM CREST IS SURVEYED RELATIVE TO SPILLWAY CREST LEVEL.
2. DATUM ELEVATION, INTERPOLATED FROM U.S.G.S. MAPS, IS THEREFORE APPROXIMATE.

PLATE 5

CLOVER DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: APR. 22, 1980

DAPPOLONIA

APPENDIX F

REGIONAL GEOLOGY

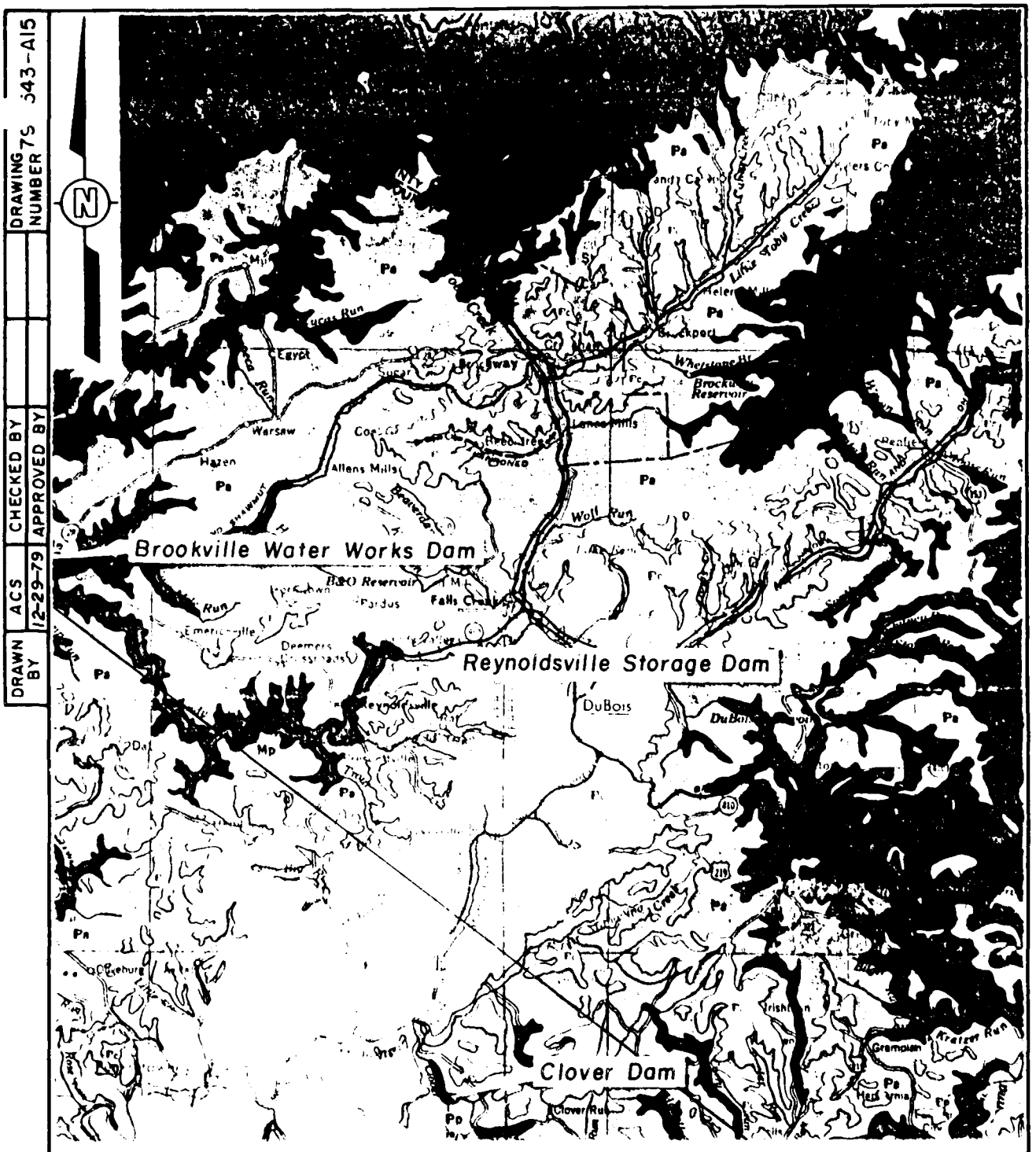
APPENDIX F

REGIONAL GEOLOGY
CLOVER DAM

Clover Dam is located in the central area of the Appalachian Plateau Province which is characterized by broad, nearly level ridges and deep steep valleys. Strata in the area have been gently folded to form the Punxsutawney Syncline, a structural feature that trends to the northeast.

The dam lies near the contact of the Allegheny and Conemaugh groups of Pennsylvanian Age. The Allegheny Group is primarily a sequence of shales and sandstones along with several minable coals. The Upper Freeport Coal delineates the Allegheny from the overlying Conemaugh which is characterized by variegated shales and thick sequences of coarse-grained sandstones. The lower half of the Conemaugh below the Ames Limestone contains numerous claystones that are prone to landslides.

The Lower Freeport Coal has been extensively strip mined north and south of the dam site.



DRAWING NUMBER 75 343-A15

DRAWN BY	CHECKED BY	APPROVED BY
ACS 12-29-79		

SCALE

0 2 4 6 8 10 miles

BROOKVILLE WATER WORKS,
REYNOLDSVILLE STORAGE AND
CLOVER DAMS

GEOLOGY MAP

REFERENCE

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA, DEPT OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

DAPPOLONIA

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER 79-043-A18
	12-31-79	APPROVED BY		

LEGEND

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals, massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections, Brush Creek Limestone in lower part of section.

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some minable coal, includes Sharp Mountain, Schuylkill, and Tumbling Run Formations

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestone Buckhorn westward, Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations

Clinton Group

Predominantly, Rose Hill Formation - Reddish purple to greenish gray, thin to medium bedded, fossiliferous shale with interbedding iron sandstones and local gray, fossiliferous limestone above the Rose Hill is brown to white quartzitic sandstone (Keefer) interbedded upward with dark gray shale (Rochester)

Dm

Marine beds

Gray to olive brown shales, graywackes, and sandstones containing Chemung beds and Portage beds excluding Bucket Brigade, Harvell, and Trimmers Rock Tully Limestone at base

Pocono Group

Predominantly gray hard massive, cross-bedded conglomerate and sandstone with some beds included in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Logan, Cussewago, Corry, and Knapp Formations includes part of Oswayo of M. J. Fuller in Potter and Tioga counties

Oriskany Formation

White to brown, fine to coarse grained, partly calcareous, locally conglomeratic, fossiliferous sandstone (Ridgeley) at the top, dark gray, cherty limestone with some interbedded shales and sandstones below (Shriver)

Tuscarora Formation

White to gray, medium to thick bedded, fine grained, quartzitic sandstone conglomeratic in part

Marcellus Formation

Black, fissile, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania.

Onondaga Formation

Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most places, includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania, in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert

Dme

Wills Creek Formation

Greenish gray, thin bedded, fissile shale with local limestone and sandstone zones, contains red shale and siltstone in the lower part.

Bloomsburg Formation

Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone, some green shale in places

McKenzie Formation

Greenish gray, thin bedded shale interbedded with gray, thin bedded, fossiliferous limestone, shale predominant at the base, intraformational breccia in the lower part. Absent in Harrisburg quadrangle and to the east

Keyser Formation

Dark gray, highly fossiliferous, thick bedded, crystalline to nodular limestone, passes into Manlius, Rondout, and Decker Formations in the east

Tonoloway Formation

Gray, highly laminated, thin bedded, argillaceous limestone, passes into Bossardville and Poxono Island beds in the east

Dck

Catskill Formation

Chiefly red to brownish shales and sandstones includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

GEOLOGY MAP LEGEND

D'APPOLONIA


DATE
FILME
8